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Report

Databases for analyzing dietary data—the latest word from *What We Eat in America*

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Abstract

The Food Surveys Research Group, part of the Agricultural Research Service (ARS) of the United States Department of Agriculture (USDA), processes several thousand 24-h dietary recalls each year for the government's survey of *What We Eat in Americ*a. The latest available intake data are from the Continuing Survey of Food Intakes by Individuals (CSFII) 1994–1996, 1998 which have been released in two forms: (1) the traditional form of food and nutrient intakes and (2) a new form described as the Food Commodity Intake Database. The latter form involved translating the CSFII data into the equivalent amounts of basic food commodities as defined by the US Environmental Protection Agency. Developed primarily for assessing risk from dietary exposure to pesticides, it provides the ability to study intakes for specific commodities, such as apples, regardless of how the food was used in various mixtures. Coding and processing survey data involves using extensive information about foods. Accordingly, ARS has developed and keeps up-to-date large technical food databases for this work, including the USDA food coding scheme, food measures and weights, recipes for food mixtures, and the Survey Nutrient Database. These databases, all publicly available, are widely used in food and nutrition research in the United States and have been used as models for databases supporting national food surveys in other countries.
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Keywords: Food database; Nutrient database; Food consumption survey; Nutrient intake; Food Commodity Intake Database; FCID; Dietary exposure to pesticides

1. Introduction

A good source of information about foods consumed in the United States is the Food Surveys Research Group (FSRG[1]), a part of the Beltsville Human Nutrition Research Center in the US

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[1] For definition of abbreviations, see Appendix A: key to abbreviations.

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Department of Agriculture's Agricultural Research Service (ARS). This group produces several databases that are widely used for studying food and nutrient consumption. The available databases include both intake databases, containing data and results from the national food consumption survey *What We Eat in America*, as well as several large technical food databases used for processing the dietary recalls collected in the survey to produce the intake databases. The latest *What We Eat in America* intake databases are from the Continuing Survey of Food Intakes by Individuals (CSFII) 1994–1996, 1998, and they include food consumption expressed in terms of nutrients and of food items and in terms of equivalent amounts of basic food commodities. The technical food databases, the tools used to translate food intake as expressed by the survey respondents into terms used in the intake databases, include the USDA food coding scheme, food measures and weights, recipes for food mixtures, the Survey Nutrient Database, and the food-code-to-commodity translation file. This paper reports on the most current FSRG databases, reviewing some of their key features and uses, and discussing some changes anticipated for the near future. Particular attention is given to the database which expresses intakes in terms of food commodities (Food Commodity Intake Database, FCID) as the newest format for release of the CSFII 1994–1996, 1998 dietary data.

2. CSFII 1994–1996, 1998 and DHKS 1994–1996

The CSFII and its companion survey, the Diet and Health Knowledge Survey (DHKS), were conducted by the US Department of Agriculture from 1994 through 1996 (Tippett & Cypel, 1997). The CSFII collected information on the kinds and amounts of foods eaten by individuals of all ages in the United States, administering two 24-h recalls on nonconsecutive days, in person, in the home. The DHKS was conducted with a subsample of adults from the CSFII age 20 years and older, who were asked over the telephone to answer a series of questions about knowledge and attitudes toward dietary guidance and health. In 1998, a survey of food intakes by children less than 10 years of age was conducted as a supplement to the CSFII 1994–1996, using the same survey methodology. In all, 21 662 individuals participated in these surveys.

Popularly called *What We Eat in America*, these surveys have spawned numerous databases that are now publicly available for research and analysis. Foremost, of course, are the specific data collected in the surveys that are used to study food and nutrient consumption, dietary related practices, and diet and health knowledge in the US population. Table 1 provides a partial list of variables included in the data sets for these surveys, as well as the web site for more information, including how to order the data on CD-ROM (USDA, 2000a). Technical food databases used to support food coding and nutrient analysis of the CSFII and other studies, and containing information on food composition, weights of food portions, and more, are described later in this paper.

3. Food Commodity Intake Database, CSFII 1994–1996, 1998

In addition to the traditional data release of food and nutrient consumption, the CSFII 1994–1996, 1998 was used to produce the FCID (US Environmental Protection Agency and US

Table 1
1994–1996, 1998 Continuing Survey of Food Intakes by Individuals, selected variables[1]

Methods
24-h diet recalls of kinds and amounts of all foods and beverages
Collected through in-person interviews, using multiple-pass method
2 non-consecutive days
Total sample
21 662 individuals of all ages
Nationally representative sample of the US population
Response rates
Day 1 82%
2-Day 78%
Food-related variables
Intake in grams
Source of food
Time and name of eating occasion
Day of the week
Month of intake
Intakes of food energy and 48 dietary components
Identification of foods eaten at home
Amount of plain drinking water
Individual variables
Age, sex, race, Hispanic origin
Education
Food sufficiency
Participation in government food assistance programs
Type and frequency of supplements
Self-assessed height and weight; body mass index
Smoking behavior, self-assessed health status, food allergies, diseases
Household variables
Region of the US
Urbanization
Household size, composition and income

[1] For more information, including how to order data on CD-ROM, access http://www.barc.usda.gov/bhnrc/foodsurvey/

Department of Agriculture, 2000). This work, conducted jointly by the Food Surveys Research Group and the Community Nutrition Research Group in ARS, and the Office of Pesticide Programs in the Environmental Protection Agency (EPA), converted the food consumption data into amounts of more than 500 food commodities as specified by the EPA. The project was undertaken to improve the assessment of dietary exposures to pesticide residues and other potentially harmful chemicals, because chemical residue data typically are available for raw agricultural commodities and not for foods as consumed. However, the database is also helpful when studying the consumption of specific food commodities for any purpose. Mixtures have

Table 2
Food Commodity Intake Database, CSFII 1994–1996, 1998

Data files	Contents
Food commodity intakes	Grams of commodity consumed per kilogram of body weight, per person per day
EPA food commodity vocabulary	Names and descriptions of over 500 EPA food commodities
Sample person data	CSFII individual variables, weighting factors
Food-code-to-commodity translation file	Grams of commodities per 100 g of USDA food codes

Available from: National Technical Information Service (NTIS). 5285 Port Royal Road, Springfield, VA 22161. Phone 1-800-553-6847. Accession Number BP 2000-500101. See website at http://www.ntis.gov/

been broken down into individual components so that a person's daily consumption of a food commodity, such as whole eggs, includes not just eggs reported separately, but those consumed as ingredients in other items as well, e.g., eggs in cake. Commodity consumption is expressed in daily per person totals as grams consumed per kilogram of body weight. Table 2 lists the information found in the FCID and the web site for obtaining the database on CD-ROM.

3.1. Translating foods to commodities

One of the first steps in development of this database was to link the CSFII food codes to the appropriate food commodities. A food-code-to-commodity translation file was created similarly to a food composition database. Instead of specifying the amount of nutrients, it specifies the amount of all commodities present in 100 g of each food. Specifications for the FCID stipulated that food commodities adhere to the EPA's definition. Since many of the EPA commodities were defined in their uncooked forms, adjustments in weights from the cooked to the uncooked forms were frequently required when the translation file was created. For example, the commodity white rice is defined as "dry weight of grain," so 100 g of cooked white rice translated to 35.7 g of the dry, uncooked form.

The starting points in the translation of food mixtures into terms of commodities were the recipes used for survey data processing. Table 3 shows the translation for CSFII food code 522-01000, "cornbread, made from a prepared mix." In the survey recipe, the ingredients for this food are egg, milk and cornbread mix. Each ingredient was translated into a list of one or more commodities. Egg was a simple translation since egg is a single agricultural commodity by EPA definition. The translation of milk was more complex. Because chemical residues may build up differently in different tissues, the EPA defines milk as three commodities—the liquid portion (Milk, water), the nonfat solids portion (Milk, nonfat solids) and the fat portion (Milk, fat). (Other examples of this type of fractionation are meats, which were separated into portions of lean, fat, and byproducts.)

Cornbread mix was translated into six different commodities based on the formulation of the dry packaged product. Commercial products of this type for which ingredients were not identified in the Survey Recipe Database were translated using product label information and procedures previously described (Marcoe & Haytowitz, 1993). Cornbread was a relatively simple translation,

Table 3
EPA food commodities in 100 g of food code 522-01000 "Cornbread, prepared from mix"

Recipe ingredient	EPA commodity description	Amount (g)
Egg	Egg, whole	6.7
Milk, not further specified	Milk, water	42.9
	Milk, nonfat solids	6.4
	Milk, fat	1.4
Cornbread mix	Wheat, flour	16.0
	Corn, field, meal	15.3
	Soybean, oil	4.7
	Sugarcane, sugar	3.3
	Beet, sugar	2.6
	Cottonseed, oil	0.4

Note: Total of commodity amounts may not equal 100 g.

since each ingredient broke down to a unique list of commodities. For many food mixtures, translation was a two-step process, first breaking down every ingredient into the simplest commodity units, then adding up the amounts of each commodity contributed by each ingredient.

For some translations, the breakdown of items was based on the proportions of commodities in the US food supply. For example, "sugar" (granulated sugar) is a very common ingredient in foods, but the source of sugar is seldom specified. In their commodity list, the EPA defines sugar as being from sugar beets or from sugarcane. For the commodity database translation, sugar was split into an estimated amount from sugar beets (44%) and the rest from sugar cane (56%), based on the National Agricultural Statistics Service estimate of refined sugar use in the United States (USDA, 1997). Another common ingredient in many recipes that was translated based on proportions of commodities in the US food supply was nonspecific vegetable oil. Based on food supply data (Putnam & Allshouse, 1996) and consultations with other USDA scientists, 75% of nonspecific vegetable oil was assigned to soybean oil and 25% to a composite of eight other food oils.

3.2. *Applications of the Food Commodity Intake Database*

The main purpose of the FCID is for estimating human exposure to pesticide residues in foods to conduct dietary risk assessments. This requires linking the food intake data, as expressed in terms of agricultural commodities, with pesticide residue databases, such as those provided by the USDA Pesticide Data Program (USDA, 2002). Information about how to conduct dietary risk assessments can be obtained from the EPA Office of Pesticide Programs, Division of Health Effects, Ariel Rios Building 1200 Pennsylvania Avenue, NW (7509C), Washington, DC 20460.

The FCID can also be used to provide estimates of commodity intakes for the whole population or for various age and sex groups. As an example, Table 4 presents mean daily intakes of three corn commodities for children age nine and under. The food-code-to-commodity translation file

Table 4
Mean consumption of three corn commodities by children 9 years of age and younger

Commodity	Grams/day	Examples of contributors
Corn meal	5.3	Ready-to-eat cereals Tortilla chips, other snacks Corn tortillas
Sweet corn	8.3	Canned, frozen, and fresh corn Vegetable soup Mixed vegetables, combinations
Corn syrup	41.4	Soft drinks Candy Fruit, canned in syrup

Source: CSFII 1994–1996, 1998, day 1, excluding breast-fed children.

can also be used to study food commodity consumption in other dietary studies if the foods have been coded with the USDA food codes.

4. Technical food databases

When surveys are publicly released, USDA includes not only the food and nutrient consumption data, but also the technical food databases that support the processing of the survey data: the Food Coding Database, the Recipe Database, and the Survey Nutrient Database (Perloff & Ahuja, 1998). Versions of the databases as used for CSFII 1994–1996, 1998 are included on the CD-ROM (USDA, 2000a). Earlier versions were used to process previous USDA national food surveys dating back to 1985, as well as the dietary data collected in the National Health and Nutrition Examination Survey (NHANES) III, conducted from 1988 to 1994 (USDHHS, 1994). Table 5 lists major attributes of each database. Information about how the databases are used to process survey data has been described in a report on the design and operation of the CSFII 1994–1996 (Tippett & Cypel, 1997) and is available on the FSRG website.

The original intent for releasing the technical food databases was to document how the consumption data were coded and processed and to facilitate secondary analyses of the survey intake data. Increasingly, the databases have become important research tools for other dietary intake studies, providing a measure of comparability with national surveys. In fact, all three technical food databases, as well as the USDA food coding software, were incorporated into the Food Intake Analysis System (FIAS). This system was developed cooperatively by the University of Texas-Houston and the USDA, for the purpose of increasing access to the CSFII survey processing methodology (Tippett & Cypel, 1997) and was used by the US Department of Health and Human Services (DHHS) to code and process the NHANES 1999–2000 (USDHHS, 2002). Not only are these databases useful for studies in the US, they have been adapted, or served as models, for national surveys in Egypt (Harrison et al., 2000), Australia (McLennan & Podger, 1997), and Israel (Goldsmith, Mayer, Magled Ben-Arie, & Kaluski, 2000).

Table 5
USDA food survey technical databases

Food Coding Database
Contains over 7300 food codes
Includes brand name foods, ethnic foods, foods modified to be higher or lower in calories, fat, and sodium
Includes over 30 000 gram weights for common portions of foods
Survey Nutrient Database
Includes data for all foods in the Food Coding Database
Values for energy, dietary fiber, cholesterol, alcohol, macronutrients (moisture, protein, fat, carbohydrate), 10 vitamins, 9 minerals, total fatty acids, and 19 individual fatty acids, caffeine, and theobromine
No missing values
Recipe Database
Documents how the Survey Nutrient Database is linked to the USDA Nutrient Database for Standard Reference
Includes descriptions and amounts of ingredients used for calculating nutrient content of mixtures

Table 6
Example of food coding database ''include statements''

Food code 418-11910: Vegetable burger or patty, meatless, no bun
Includes
Amy's California Veggie Burger®
Gardenburger Fire Roasted Vegetable®
Gardenburger Original®
Gardenburger Savory Mushroom®
Gardenburger Veggie Medley®
Gardenburger Zesty Bean®
Gardenburger®, not further specified
Vegetarian burger made with rice and vegetables

The Food Coding Database contains descriptive data for more than 7300 foods. Many brand names are included. For ready-to-eat breakfast cereals, infant formulas and candy bars, specific items are usually described by the brand name. For other food groups, brand names are linked to generic food names through a special database file of ''include statements''. Table 6 shows an example of the brand names, and other descriptions, linked to one generic food item—vegetable burger. These items are grouped together because they have similar nutrient profiles and portion weights. Including all of the various names in the database facilitates the food coding process.

The Food Coding Database also contains more than 30 000 weights of common portions and typical measures of foods. These are used to convert portions as reported by survey respondents into gram weights to be used with the Survey Nutrient Database for calculating the nutrient content of each portion. For each food in the database, weights are present for measures specific to that food. Table 7 provides a few examples: the ready-to-eat breakfast cereal Cheerios® needs

Table 7
Survey weights and measures examples

Food	Measure	Weight (g)
Cheerios®-Food code 571-23000	10 Cheerios®	0.9
	1 cup	30.0
	1 single serving box (.75 oz)	21.0
	use if quantity not specified	28.0
White bread-Food code 511-01000	1 very thin slice	15.0
	1 thin slice	20.0
	1 regular slice	26.0
	1 large slice	30.0
	1 slice, crust not eaten	12.0
	1 thin slice, crust not eaten	9.0
	1 cup, cubes	35.0
	Use if quantity not specified	26.0

only a few measures for coding purposes; in contrast, the generic food ''white bread'' requires several because it is reported in these different ways.

The Recipe Database contains an entry for each food code in the Food Coding Database. This entry links the food code to the food composition data in the USDA Nutrient Database for Standard Reference (SR). The recipe files use approximately 3000 basic SR foods, combining them as recipe ingredients to create nutrient profiles for the 7300 plus survey food codes. The recipe entry serves as a formula for calculating nutrients when the link to the SR data is not a simple and direct, one-to-one link. It includes a complete list of ingredients and their amounts. When appropriate, ingredients are linked to retention factors (from a file in the Survey Nutrient Database) that are used to account for the losses of vitamins and minerals during cooking. Recipes also include factors for calculating moisture and fat changes that occur during cooking; for example, the evaporation of moisture when a stew is cooked, or the absorption of fat when potatoes are fried. The database includes modified forms of the recipes that were used for nutrient analysis of CSFII when survey respondents reported specific cooking fats, meat or milk ingredients, or dilution factors that differed from the original database entries. Although not originally designed for this purpose, the recipe database is increasingly being used to examine consumption at the ingredient or basic food level, such as for the FCID and the Pyramid Servings Database.

The Survey Nutrient Database includes values for food energy and 50 other food components, as listed in Table 5. Several data files are included in this database. One file includes sets of nutrient values for each survey food code. Another file contains the values for each of the approximately 3000 ingredients used in the Recipe Database. This latter file, called the Primary Data Set (PDS), is provided by the ARS Nutrient Data Laboratory (NDL). Basically, the PDS is a subset of the USDA Nutrient Database for Standard Reference (USDA, 1999), but also includes some codes that were developed specially for survey use. Other files in the Survey Nutrient Database include a set of retention factors for use in recipe calculations and a nutrient description file. Several changes are underway for future releases of this database, as described below.

The Pyramid Servings Database is used for analyzing dietary data in terms of numbers of food servings. Originally prepared by the Food Surveys Research Group and now produced by the Community Nutrition Research Group (CNRG) in ARS, this database presents numbers of servings for 30 food groups and subgroups in 100 g of foods. Foods correspond to the USDA food codes. Serving sizes and food groups are based on recommendations of the Food Guide Pyramid (Cleveland, Cook, Krebs-Smith, & Friday, 1997). The Pyramid Servings Database can be downloaded from the CNRG web site (USDA, 2000b).

5. Upcoming changes

In 2002, the USDA CSFII was merged with the dietary component of the US Department of Health and Human Services (DHHS) National Health and Nutrition Examination Survey (NHANES) to form a new, integrated survey of *What We Eat in America*. The USDA data collection method, food coding and nutrient analysis software programs, as well as updated versions of the technical food databases, have been incorporated into the new, integrated survey. The USDA-ARS Food Surveys Research Group will continue to update and release the intake and the technical food databases. Several enhancements will occur in the Survey Nutrient Database before the 2002 dietary data are analyzed. First, the PDS will no longer be a separate, unique file; instead, data for all the recipe ingredient codes will be taken directly from the latest release of the USDA Nutrient Database for Standard Reference. This means that special reference codes and statistical data now available in the SR will be directly linkable to values in the Survey Nutrient Database. In addition, changes in units for folate, vitamin A and vitamin E will correspond with the latest Dietary Reference Intakes (DRIs), and new values for some individual carotenoids, total sugars, and vitamin K will be incorporated from the SR as soon as they are available.

6. Tracking changes over time—real differences vs. improved data

An important aspect of the USDA technical food databases is the method for tracking changes that occur in food data over time (Anderson, Perloff, Ahuja, & Raper, 2001). When nutrient values, food weights, or recipes are revised to represent improved data, those changes are made retroactive to past years. But sometimes changes represent real, true differences in foods from one time period to another. In those cases, the old values are not replaced; instead, they are kept to represent the past and new records are added for the newer values. Such multiple records for a single item are distinguished by fields for start- and end-dates, to mark the period of time when each value is valid. This method allows the databases to be used for analysis of current dietary intake data and also to be used in re-analysis of data collected in earlier time periods (Guenther, Perloff, & Vizioli, 1994).

The example shown in Table 8 includes the records from the Survey Nutrient Database for the folate content of 100 g of white bread. The fortification level changed in 1998, so intake data collected in 1998 and later should be analyzed for folate content with the higher level. If earlier intake data are re-analyzed to incorporate newer, improved nutrient data, folate analysis will continue to use the older values that represent the pre-fortification level for bread and other fortified foods.

Table 8
Multi-version database example—folate in 100 g of white bread

Food	Start date (M/D/Y)	End date (M/D/Y)	Total Folate (μg)
Bread, white-Food code 511-01000	01/01/1994	11/30/1997	34.0
	12/01/1997	—	95.0

Note: The 1994–1998 USDA Survey Nutrient Database contained only one unit for folate (total folate in μg). Beginning in 2002, folate is expressed as μg of total folate, folic acid, food folate, and dietary folate equivalents (DFE).

7. Conclusions

The Food Surveys Research Group (FSRG) of the US Department of Agriculture's Agricultural Research Service (ARS) has released several databases from the latest *What We Eat in America* survey (CSFII 1994–1996, 1998) that are available for research and analysis. The consumption data are available in two forms to facilitate their use: (1) the traditional form of food and nutrient intakes and (2) a new form described as the Food Commodity Intake Database (FCID). The latter database involved translating the CSFII data into the equivalent amounts of basic food commodities as defined by the US Environmental Protection Agency (EPA). The FCID was developed jointly by the ARS and the EPA, primarily for assessing risk from dietary exposure to pesticides. It also facilitates studying the consumption of specific commodities, since the intake estimates include all sources of a commodity, even small amounts from mixtures. Along with the two forms of consumption data, several large technical food databases that were used to code or otherwise process the CSFII, have also been made available by the FSRG. These databases can be used by researchers for their own smaller studies, and have been used in part for national surveys in other countries. These technical food databases include the USDA food coding scheme, food measures and weights, recipes for food mixtures, the Survey Nutrient Database, and the food-code-to-commodity translation file.

Disclaimer

Mention of commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the US Department of Agriculture over others not mentioned.

Appendix A. Key to abbreviations

Abbreviation	*Full name*
ARS	Agricultural Research Service
CNRG	Community Nutrition Research Group
CSFII	Continuing Survey of Food Intakes by Individuals
DHHS	US Department of Health and Human Services
DHKS	Diet and Health Knowledge Survey

EPA	US Environmental Protection Agency
FCID	Food Commodity Intake Database
FSRG	Food Surveys Research Group
NDL	Nutrient Data Laboratory
NHANES	National Health and Nutrition Examination Survey
PDS	Primary Data Set
SR	US Nutrient Database for Standard Reference
USDA	US Department of Agriculture

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